Inversion of GRACE Gravity for Global Surface Mass Variations

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Objective

- Convert sat-to-sat gravity measurements into global surface mass variation as a function of space and time

- Assess separability of geophysical sources, accuracy, resolution, and role of complementary data

Forward Model

$$g^i(t) = \iint_{\Omega} E_g^i(\Omega) M(\Omega, t) d\Omega + \Delta^i$$

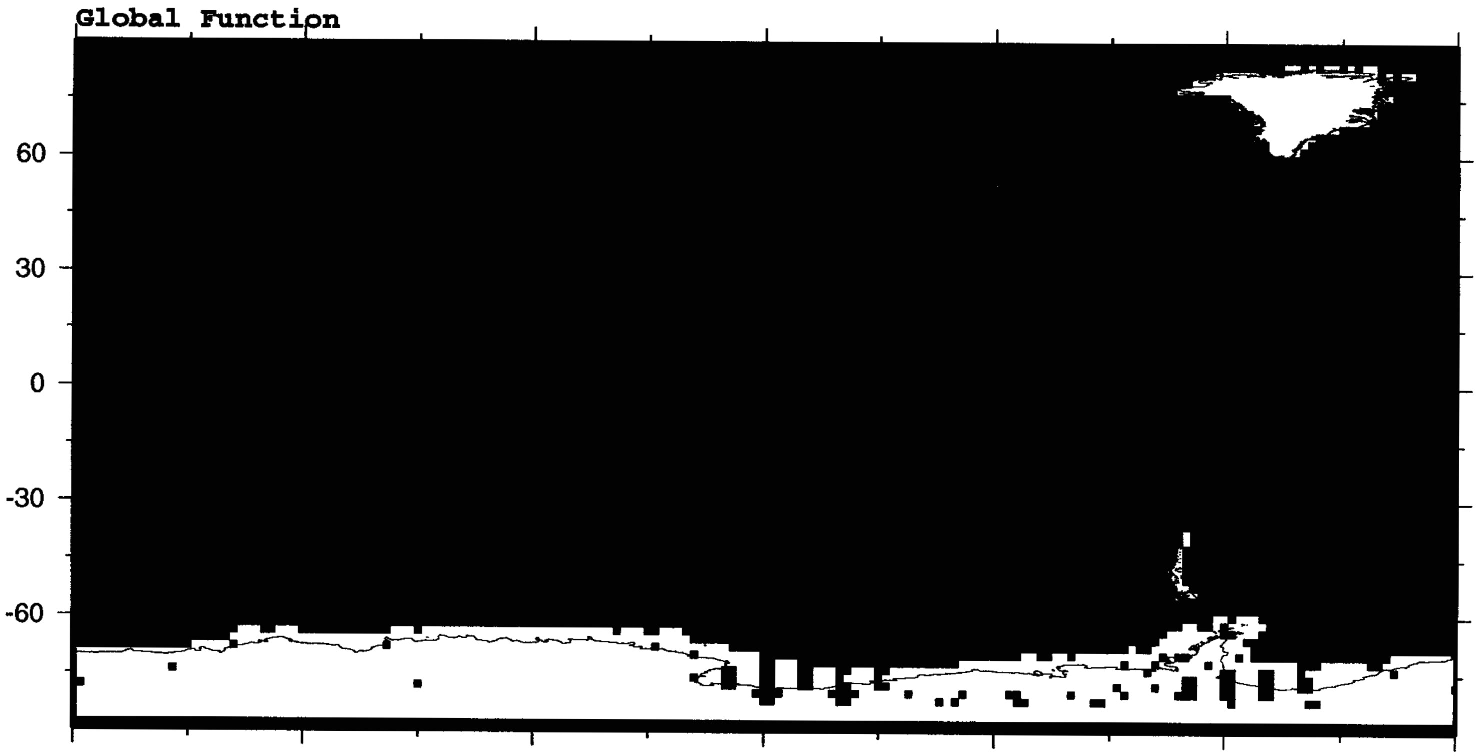
$$\dot{g}^i = \iint_{\Omega} E_g^i(\Omega) \dot{M}(\Omega) d\Omega + \int_{-\infty}^{t} \iint_{\Omega} V_g^i(\Omega, t - t') M(\Omega, t') d\Omega dt'$$

$$L = AX + BY + CZ + \Delta$$

Simultaneous Global Solution

Why?

- Spatial coupling of gravity signal
- Alias across geographic boundaries
- Clear definition of derived quantities
- Exact posterior covariance
- Platform for future simultaneous non-linear inversion of radial mantle viscosity profile and ice load


Global Function
60
30
0
-30
-60

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Simultaneous Global Solution

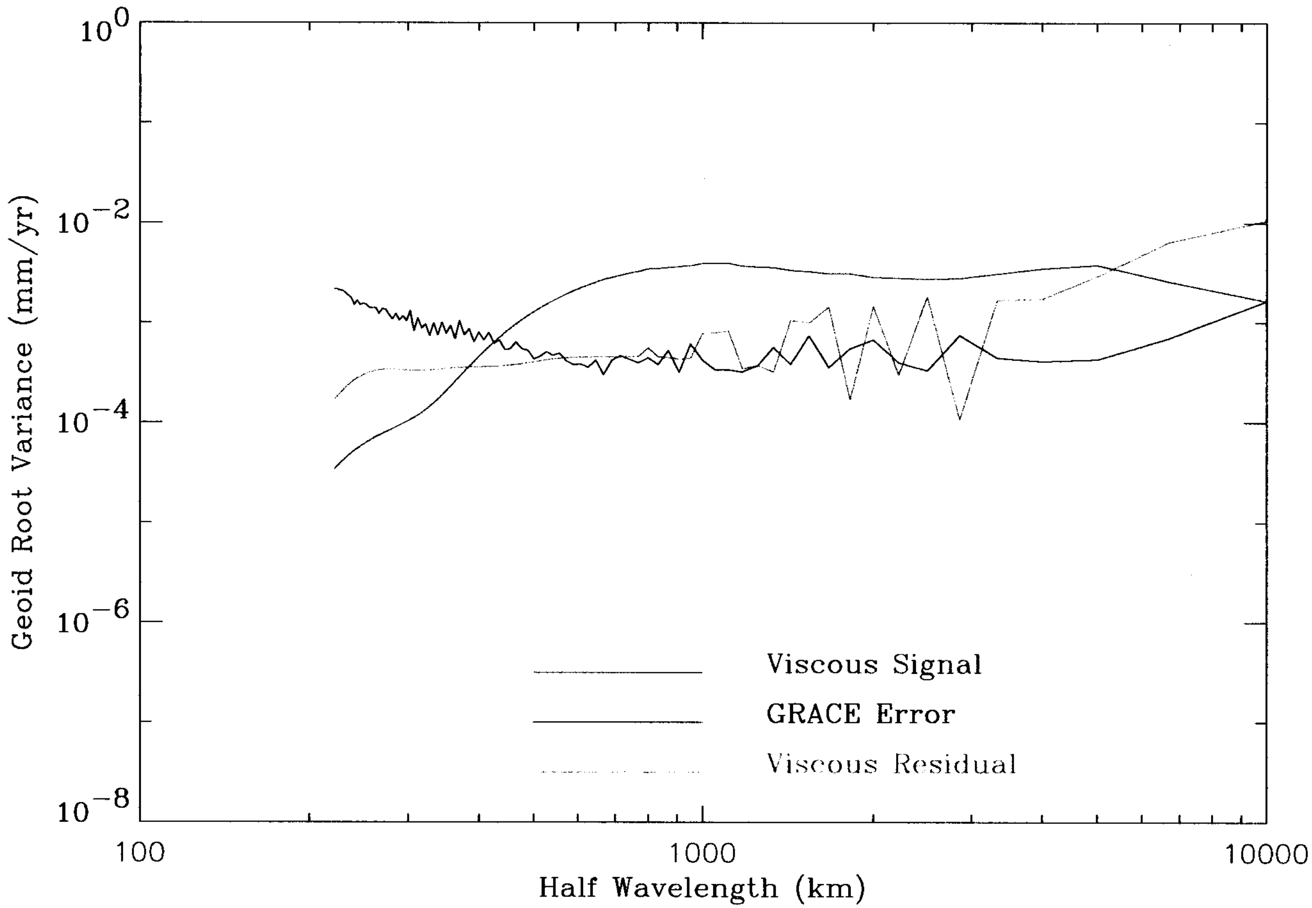
Data:

- GRACE gravity harmonic rates up to degree/order 90
- Altimeter height change rate over Greenland and Antarctica $\sigma = 2$ cm/yr

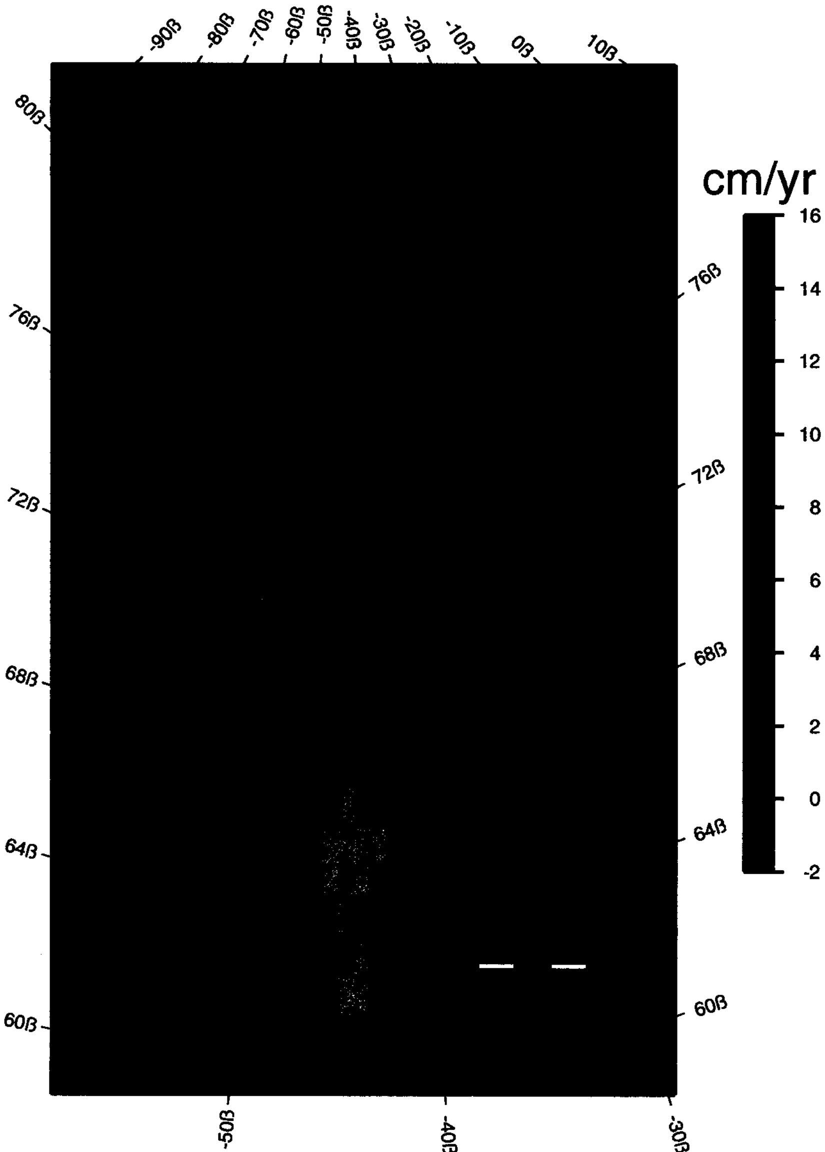
Parameters:

over 300 kmX300 km grids

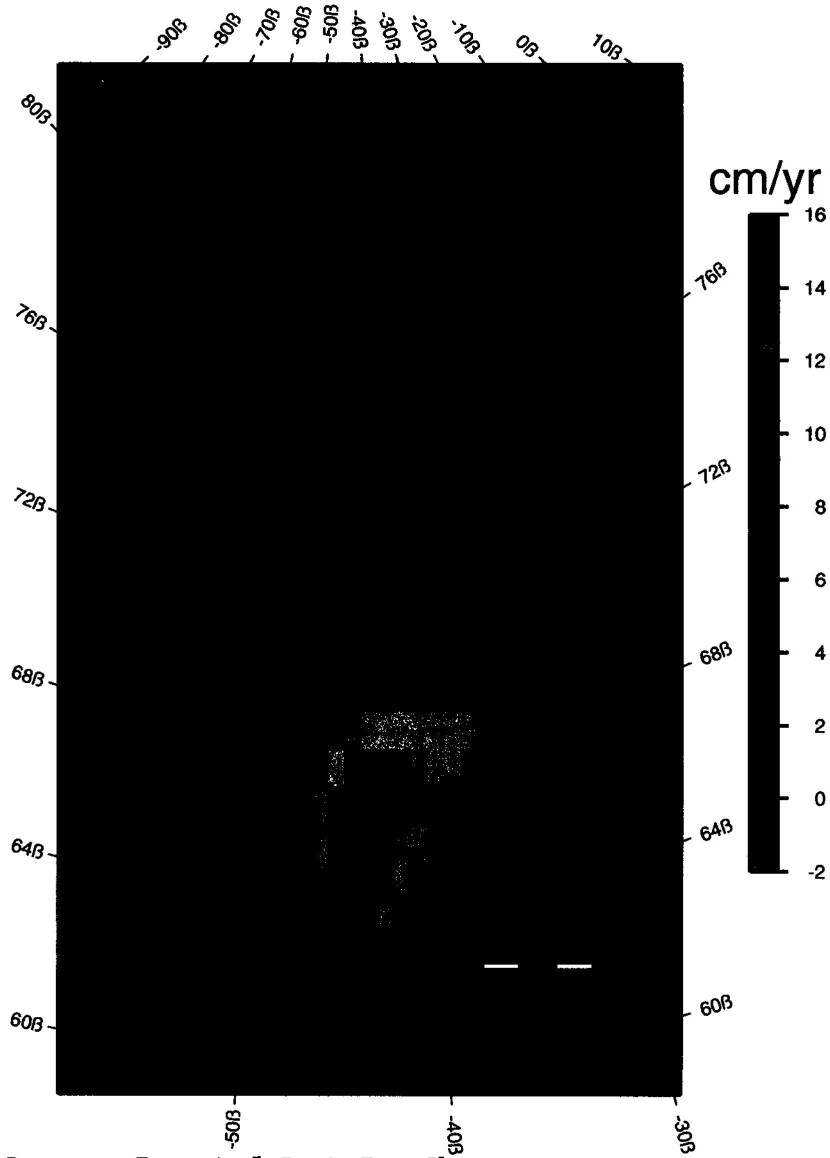
- Current and past ice mass variations over Greenland and Antarctica
- Deglaciation of ancient ice sheets
- Global oceanic mass variation
- Global hydrological mass variations



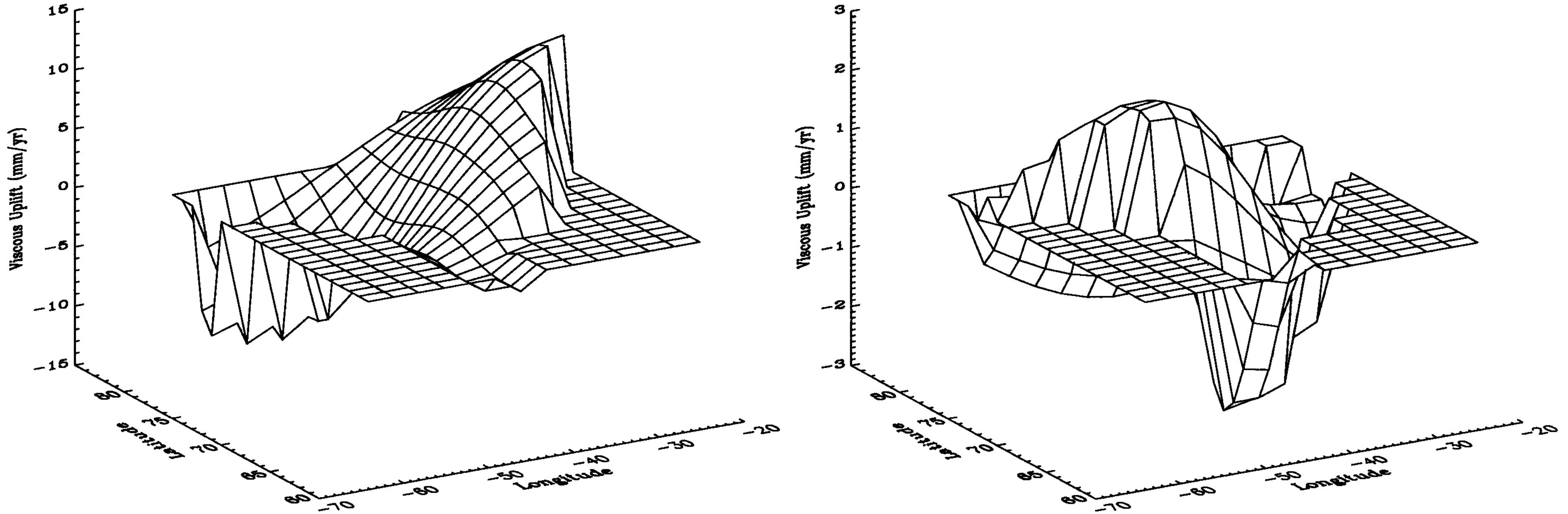
10^0
10^{-2}
10^{-4}
10^{-6}
10^{-8}
Geoid Root Variance (mm/yr)
100
1000
10000
Half Wavelength (km)
Viscous Signal
GRACE Error
Viscous Residual



a. Average Possible Past Ice Change



b. Average Inverted Past Ice Change



Viscous Uplift (mm/yr)
15
10
5
0
-5
-10
-15
80
75
70
65
60
Latitude
-70
-60
-50
-40
-30
-20
Longitude
Viscous Uplift (mm/yr)
3
2
1
0
-1
-2
-3
80
75
70
65
60
Latitude
-70
-60
-50
-40
-30
-20
Longitude